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Research Article

A comparative study of the external male genitalia in the subfamily Zeugophorinae, and a new species of genus *Zeugophora* (Coleoptera, Megalopodidae) from China

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Abstract

The external male genitalia of 21 Chinese species of the genus *Zeugophora* (subfamily Zeugophorinae) are compared. A key is compiled to Chinese *Zeugophora* species based on external male genitalia with aid of other external morphological traits. One new species, *Zeugophora* (*Pedrillia*) *liupanshanensis* Li & Liang, **sp. nov.,** is described from Ningxia Hui Autonomous Region, China.

Key words: Key, median lobe, median struts, *Pedrillia*, spiculum, tegmen

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Introduction

The external male genitalia of Megalopodidae consist of a median lobe, a pair of median struts, a tegmen, an internal sac and a spiculum (belonging to the 9th abdominal segment) (Snodgrass 1935; Chen 1940; Verma 1996). They are among the most important identification characteristics in the Megalopodidae and receive much attention from taxonomists. Chûjô (1952, 1953) studied the morphology of external male genitalia of the Megalopodinae and Zeugophorinae extensively and found similarities between these two subfamilies. Subsequently, taxonomists began to pay attention to the male genitalia of the Megalopodidae when describing new species and constructing phylogenetic relationships within the Chrysomeloidea (Reid 1989, 1998; Kuschel and May 1990; Mann and Crowson 1996; Verma 1996; Medvedev 1997; Li et al. 2013; Li and Liang 2018, 2020; Rodríguez-Mirón et al. 2021).

The current classification of the genus *Zeugophora* is unstable. Some authors treated *Pedrillia* Westwood, 1864 as a distinct genus of the Zeugophorinae (Baly 1873; Jacoby 1908; Chûjô 1935, 1937) or as a subgenus of *Zeugophora* (Monrós 1959; Gressitt and Kimoto 1961; Chen and Pu 1962; Kimoto and Gressitt 1979; Medvedev 1985, 1997; Reid 1989, 1992, 1995; Schöller 2009; Silfverberg 2010; Warchałowshi 2010; Li and Liang 2018, 2020), while other authors treated *Pedrillia* as a synonym of the genus *Zeu-*

gophora (Sekerka and Vives 2013; Rodríguez-Mirón, 2018; Takemoto, 2019; Rodríguez-Mirón et al. 2021). We accept that *Pedrillia* is a subgenus of the genus *Zeugophora* because *Pedrillia* can be separated from *Zeugophora* on external morphology, external male and female genitalia, and host plants, at least for Chinese species. A total of 34 species of subfamily Zeugophorinae has been recorded in China (Lee and Cheng 2007; Li and Liang 2018, 2020). In *Pedrillia*, it is difficult to determine certain species based only on external morphological characteristics; therefore, we attempted to find characteristics of external male genitalia to aid its classification. The comparison of female genitalia was not included in this study owing to insufficient specimen material in several species. In this study, we describe and compare 21 available Chinese species of Zeugophorinae to summarize key characteristics of external male genitalia for distinguishing subgenera and species within the Chinese fauna.

With accumulating information about the host plants of Zeugophorinae during expeditions in China, we found that plants of the family Celastraceae are hosted by a few species, such as *Zeugophora* (*Pedrillia*) *annulata* (Baly, 1873), *Z.* (*P.*) *bicolor* (Kraatz, 1879), *Z.* (*P.*) *nigricollis* (Jacoby, 1885), *Z.* (*P.*) *ruficollis* Chûjô, 1932, *Z.* (*P.*) *decorata* Chûjô, 1937, *Z.* (*P.*) *formosana* (Gressitt, 1945), *Z.* (*P.*) *tricolor* Chen & Pu, 1962, *Z.* (*P.*) *euonymorum* Li & Liang, 2020 (Lee and Cheng 2007; Li and Liang 2018, 2020). In recent years, we focused on trees of Celastraceae when surveying Zeugophorinae. In 2018, two specimens were collected by beating plants of the family Celastraceae in Ningxia Hui Autonomous Region. We compared them with all known species, and found they represented a new species, described in this paper.

Materials and methods

Preparation of specimens

Dry specimens were soaked in water for 1–2 h. The lateral margin of the abdomen was opened and the genitalia were pulled out of the abdomen with fine forceps. The genitalia were soaked in a warm solution of 10% KOH for 10–20 min. After treatment, these organs were washed with water. The genitalia were then detached and transferred to glycerin for observation, photography, and preservation.

All measurements were made using a Nikon SMZ1500 or Nikon SMZ18 stereoscopic microscope with the aid of an ocular micrometer. Body length (**BL**) = the linear distance along the midline from the anterior margin of the labrum to the apex of the elytra; body width (**BW**) = elytra width (**EW**) = the maximum linear distance across the elytra; pronotum length (**PL**) = the linear distance along the median line of the pronotum; pronotum width (**PW**) = the linear distance across the widest part of the pronotum; elytra length (**EL**) = the linear distance from the base of the elytra to the apex of the sutural angle; median lobe length = the linear distance from the base to the apex; median struts length = the linear distance from the base to the apex. Ratios cited in descriptions are based on these measurements.

Photographs of male genitalia were taken using a Nikon SMZ-1500 stereoscopic dissecting microscope fitted with a Cannon 450D digital camera, or a

Nikon SMZ18 stereoscopic dissecting microscope fitted with a Nikon D610 digital camera. For each final image, several photographs were taken using different focal planes, combined with Helicon Focus software to obtain one synthesized photograph, and finally edited with Adobe Photoshop software.

Terminology

Morphological terminology for male genitalia follows Snodgrass (1935), Verma (1996), Chûjô (1952, 1953), Kasap and Crowson (1985), Li and Liang (2018, 2020), and Li et al. (2013).

Abbreviations and acronyms

The abbreviation **TL** means type locality. The abbreviation **TD** means type depository.

The abbreviations used in the descriptions are as follows:

BFU	Beijing Forestry University, Beijing, China.
CAS	California Academy of Sciences, San Francisco, California, USA.
IZCAS	National Zoological Museum of China, Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
KIZ	Kunming Natural History Museum of Zoology, Kunming Institute of Zoology, Chinese Academy of Sciences, Kunming, China.
MZPW	Polish Academy of Science, Museum of the Institute of Zoology, Warsaw, Poland.
NHMUK	The Natural History Museum, London, UK.
NSMK	National Science Museum, Korea.
SCBG	Shanghai Chenshan Botanical Garden, Shanghai, China.
SDEI	Deutsches Entomologisches Institut, Eberswalde, Germany.
ZIN	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

Species studied

A total of 21 available *Zeugophora* (subgenera *Zeugophora* and *Pedrillia*) species belonging subfamily Zeugophorinae were examined (Table 1).

Results

Key to species of the genus *Zeugophora*

1 Median strut short, ratio of median strut / median lobe ≤ 1.5 (subgenus *Zeugophora*) **2**

– Median strut long, ratio of median strut / median lobe ≥ 2.0 (subgenus *Pedrillia*) **7**

2 Median lobe with apical portion gradually narrowed towards apex, apex blunt or sharp (Figs 2, 18, 23); host plant genus *Populus* **3**

– Median lobe with apical portion abruptly narrowed towards apex, apex sharp (Figs 7, 10, 15); host plant genus *Salix* **5**

3 Median lobe with apical portion broad, apex blunt (Fig. 2) ..... ***Zeugophora* (*Z.*) *ancora* Reitter**

– Median lobe with apical portion narrow, apex sharp (Figs 18, 23)..... **4**

4 Dorso-central portion of median lobe without a sclerite (Fig. 18) ..... ***Zeugophora* (*Z.*) *scutellaris* Suffrian**

– Dorso-central portion of median lobe with a sclerite (Fig. 23)..... ***Zeugophora* (*Z.*) *turneri* Power**

5 Apical portion of median lobe slightly broad (Fig. 7)..... ***Zeugophora* (*Z.*) *cribrata* Chen**

– Apical portion of median lobe slightly narrow (Figs 10, 15)..... **6**

6 Apex of median lobe slightly long (Fig. 15) ..... ***Zeugophora* (*Z.*) *nigroarea* Lopatin**

– Apex of median lobe slightly short (Fig. 10)..... ***Zeugophora* (*Z.*) *cyanea* Chen**

7 Sides of the median lobe narrow in basal and apical portion (Figs 39, 65) **8**

– Sides of median lobe parallel or sub-parallel **9**

8 Median basal portion lobe broader, apex strongly narrowed and bent downward;median strut short; tegmen strongly sclerotized (Figs 38–40) . ..... ***Zeugophora* (*P.*) *emeica* Li & Liang**

– Median lobe elongate, apex slightly swollen laterally; median strut long; tegmen slightly sclerotized (Figs 64–66) ..... ***Zeugophora* (*P.*) *nigroapica* Li & Liang**

9 Sides of median lobe parallel; dorso-central portion of median lobe with a sclerite (Figs 34, 73)..... **10**

– Sides of median lobe parallel, sub-parallel or not parallel; dorso-central portion of median lobe without a sclerite..... **11**

10 Sclerite of median lobe in dorso-central area weak; sides of spiculum longer than central portion (Figs 34, 36)..... ***Zeugophora* (*P.*) *dimorpha* Gressitt**

– Sclerite of median lobe in dorso-central area strong; sides of spiculum shorter than central portion (Figs 72, 75)..... ***Zeugophora* (*P.*) *trifasciata* Li & Liang**

11 Median lobe with dorso-central portion membranous, basal 1/3 not tubular; the sides of median lobe thin (Figs 47, 58, 82); host plant Symplocaceae..... **12**

– Median lobe with dorso-central portion membranous, basal 1/3 tubular; sides of median lobe thick; host plant Lamiaceae or Celastraceae **14**

12 Ratio of median strut / median lobe ~3.0; apex of median lobe sharp (Figs 81, 82); apical portion of spiculum trifid..... ***Zeugophora* (*P.*) *yunnanica* Chen & Pu**

– Ratio of median strut / median lobe 1.5–2.0; apex of median lobe blunt or prominent; apical portion of spiculum not trifid (Figs 46, 47, 57, 58) **13**

13 Median lobe apical portion slightly broad, apical margin projecting and flattened (Fig. 47)..... ***Zeugophora* (*P.*) *flavithorax* Li & Liang**

– Median lobe apical portion slightly narrow, apical margin blunt and bent downward medially (Fig. 58) ..... ***Zeugophora* (*P.*) *maculata* Chûjô**

14 Ratio of median strut / median lobe > 3.0; host plant Lamiaceae **15**
– Ratio of median strut / median lobe < 3.0; host plant Celastraceae.....**17**
15 Median lobe strongly curved in lateral view, apical portion strongly upward curved, apex sharp (Figs 54, 55) .... ***Zeugophora* (*P.*) *longicornis* (Westwood)**
– Median lobe curved in lateral view, apical portion flattened, apex blunt **16**
16 Median lobe elongate, sides slightly narrowed in middle, apex slightly short (Figs 76, 77) .....***Zeugophora* (*P.*) *yuae* Li & Liang**
– Median lobe slightly broad and short, sides paralleled, apex slightly long (Figs 49, 50) ..... ***Zeugophora* (*P.*) *indica* Jacoby**
17 Median lobe basal portion curved in lateral view (Figs 41, 60, 92, 97) **18**
– Median lobe basal and apical portion curved in lateral view (Figs 25, 30, 69) **20**
18 Media lobe short, apex broad (Figs 41, 42) ....***Zeugophora* (*P.*) *euonymorum* Li & Liang**
– Median lobe elongate, apex narrow **19**
19 Apical portion of median lobe broad (Fig. 61)..... ..... ***Zeugophora* (*P.*) *nigricollis* (Jacoby)**
– Apical portion of median lobe narrow (Figs 93, 98)..... ..... ***Zeugophora* (*P.*) *liupanshanensis* sp. nov.**
20 Apex of median lobe slightly curved Leftward (Fig. 31), basal piece of tegmen long (Fig. 32) ..... ***Zeugophora* (*P.*) *bicolor* (Kraatz)**
– Apex of median lobe not curved Leftward (Figs 26, 70), basal piece of tegmen short (Figs 27, 71) **21**
21 Apex of the median lobe long and sharp (Fig. 26) .... ***Zeugophora* (*P.*) *annulata* (Baly)**
– Apex of median lobe short and blunt (Fig. 70)..... .....***Zeugophora* (*P.*) *tricolor* Chen & Pu**

Zeugophorinae Boving & Craighead, 1931
Genus *Zeugophora* Kunze, 1818

Subgenus *Zeugophora* Kunze, 1818

External male genitalia. (Figs 1–24) Median lobe generally strongly sclerotized, slender, dorso-central portion membranous with or without a long narrow sclerite, curved in lateral view, sides thin, sub-parallel, apex narrower than base, apical portion tongue shaped, blunt, or triangular and sharp; median struts rod-shaped, widely separated from each other, ~1.1–1.4× as long as median lobe; base of tegmen slightly Y-shaped, tegminal ring with base broad and gradually narrow to apical portion, apex sub-square, paramere sub-square, apical margin with dense setae; endophallus membranous, with a paired granulated area, sclerotized or weakly sclerotized. Spiculum long, Y-shaped, strongly sclerotized, apical portion trifid, slightly sclerotized.

The apical portion of median lobe with a long narrow sclerite in *Zeugophora* (*Zeugophora*) *ancora*, *Z.* (*Z.*) *cribrata*, *Z.* (*Z.*) *cyanea*, *Z.* (*Z.*) *nigroaerea*, and *Z.* (*Z.*) *turneri* (Figs 2, 7, 10, 15, 23) but not in *Z.* (*Z.*) *scutellaris* (Fig. 18).

Table 1. Species list of Zeugophorinae studied in this paper.

Species	Locality	Specimen status	Host plant
Zeugophora (*Zeugophora*) *ancora* Reitter, 1900	Ningxia	common	Salicaceae: *Populus nigra* var. *italica* (Moench) Koehne, *Populus alba* L.
Zeugophora (*Z.*) *cribrata* Chen, 1974	Qinghai	paratype	Salicaceae: *Salix* L.
Zeugophora (*Z.*) *cyanea* Chen, 1974	Sichuan, Qinghai	specimen compared with holotype	Salicaceae: *Salix* L.
Zeugophora (*Z.*) *nigroaerea* Lopatin, 2008	Gansu, Shaanxi	specimen compared with holotype	Salicaceae: *Salix* L.
Zeugophora (*Z.*) *scutellaris* Suffrian, 1840	Inner Mongolia	common	Salicaceae: *Populus acuminata* Rydberg, *P. alba* L., *P. deltoides* Marshall, *P. grandidentata* Michaux, *P. nigra* L., *P. tremula* L., *Salix* sp.
Zeugophora (*Z.*) *turneri* Power, 1863	Beijing	common	Salicaceae: *Populus* sp.
Zeugophora (*Pedrillia*) *annulata* (Baly, 1873)	Ningxia	common	Celastraceae: *Euonymus alatus* (Thunb.) Siebold, *Euonymus przewalskii* Maxim., *Euonymus phellomanus* Loes. ex Diels. *Euonymus maacki* Rupr. and *E. sacrosancta* Koidz.
Zeugophora (*P.*) *bicolor* (Kraatz, 1879)	Liaoning	specimen compared with holotype	Celastraceae: *Celastrus orbiculatus* Thunb.
Zeugophora (*P.*) *dimorpha* Gressitt, 1945	Hunan	specimen compared with paratype	unknown
Zeugophora (*P.*) *emeica* Li & Liang, 2018	Sichuan	holotype	unknown
Zeugophora (*P.*) *euonymorum* Li & Liang, 2020	Yunnan	holotype	Celastraceae: *Euonymus alatus* (Thunb.) Siebold, *Euonymus hamiltonianus* Wall.
Zeugophora (*P.*) *flavithorax* Li & Liang, 2020	Yunnan	holotype	Symplocaceae
Zeugophora (*P.*) *indica* Jacoby, 1903	Yunnan	specimen compared with holotype	possible Lamiaceae: *Vitex quinata* (Lour.) Will.
Zeugophora (*P.*) *longicornis* (Westwood, 1864)	Yunnan	specimen compared with type	possible Lamiaceae: *Vitex quinata* (Lour.) Will.
Zeugophora (*P.*) *maculata* Chûjô, 1941	Guizhou	common	Symplocaceae: *Symplocos sumuntia* Buch.-Ham. ex D. Don
Zeugophora (*P.*) *nigricollis* (Jacoby, 1885)	Ningxia	common	Celastraceae: *Euonymus alatus* (Thunb.) Siebold
Zeugophora (*P.*) *nigroapica* Li & Liang, 2018	Yunnan	holotype	unknown
Zeugophora (*P.*) *tricolor* Chen & Pu, 1962	Ningxia	specimen compared with holotype	Celastraceae: *Euonymus alatus* (Thunb.) Siebold
Zeugophora (*P.*) *trifasciata* Li & Liang, 2020	Yunnan	holotype	unknown
Zeugophora (*P.*) *yuae* Li & Liang, 2020	Yunnan	holotype	possible Lamiaceae: *Vitex quinata* (Lour.) Will.
Zeugophora (*P.*) *yunnanica* Chen & Pu, 1962	Yunnan	specimen compared with holotype	Symplocaceae: *Symplocos* sp.

***Zeugophora* (*Zeugophora*) *ancora* Reitter, 1900**
Figs 1–4

Zeugophora ancora Reitter, 1900: 164, pl. 1, fig. 9. TL: C. Asia (Donkyr). TD: unknown.
Zeugophora ancora var. *pseudancora* Reitter, 1900: 165.
Zeugophora (*Pedrillia*) *ancora*: Jolivet 1957: 12.

Host plants. Salicaceae: *Populus nigra* var. *italica* (Moench) Koehne, *Populus alba* L. (Wu et al. 1982).

Remarks. The median lobe of this species is similar to that of *Zeugophora* (*Zeugophora*) *cyanea*, *Z.* (*Z.*). *cribrata*, *Z.* (*Z.*) *nigroaerea*, and *Z.* (*Z.*) *turneri* in having the dorso-central portion of the median lobe with a sclerite (Figs 7, 10, 15, 23), but differs in having the apex of median lobe blunt.

***Zeugophora* (*Zeugophora*) *cribrata* Chen, 1974**
Figs 5–8

Zeugophora cribrata Chen, 1974: 43, 44, 47, fig. 1A. TL: China, Qinghai. TD: IZCAS.

Host plant. Salicaceae: *Salix* L. (Chen 1974; pers. obs.).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Zeugophora*) *cyanea*, but differ in having the median lobe slightly broader (median lobe slightly narrower in *Z.* (*Z.*) *cyanea*, Fig. 10).

Figures 1–8. Male genitalia of *Zeugophora* (*Zeugophora*) species. **1–4.** *Z.* (*Z.*) *ancora* Reitter, 1900; **1.** Median lobe and median struts, lateral view; **2.** Median lobe, dorsal view; **3.** Tegmen, dorsal view; **4.** Spiculum, dorsal view; **5–8.** *Z.* (*Z.*) *cribrata* Chen, 1974; **5.** Spiculum, dorsal view; **6.** Median lobe and median struts, lateral view; **7.** Median lobe, dorsal view; **8.** Tegmen, dorsal view. Scale bar: 2 mm.

Zeugophora (*Zeugophora*) *cyanea* Chen, 1974

Figs 9–12

Zeugophora cyanea Chen, 1974: 44, 45, 47. TL: China, Qinghai. TD: IZCAS.

Host plant. Salicaceae: *Salix* L. (Chen 1974; pers. obs.).

Remarks. The similarities and differences of external male genitalia between this species and *Zeugophora* (*Zeugophora*) *cribrata* are provided in the remarks under *Z.* (*Z.*) *cribrata*.

Zeugophora (*Zeugophora*) *nigroaerea* Lopatin, 2008

Figs 13–16

Zeugophora nigroaerea Lopatin, 2008: 918–927. TL: China (Gansu). TD: ZIN.

Host plant. Salicaceae: *Salix* L. (pers. obs.).

Remarks. The external male genitalia of this species are most similar to those of *Zeugophora* (*Zeugophora*) *cyanea* (Figs 9–12), but differ in having the median lobe slightly longer (median lobe slightly shorter in *Z.* (*Z.*) *cyanea*, Fig. 10). This species is also similar to *Z.* (*Z.*) *cribrata* (Figs 5–8), but differs from it in having the apex of the median lobe slightly narrower (apex of median lobe slightly broader in *Z.* (*Z.*) *cribrata*, Fig. 7).

Zeugophora (*Zeugophora*) *scutellaris* Suffrian, 1840

Figs 17–20

Zeugophora scutellaris Suffrian, 1840: 99. TL: Germany (Aschersleben, Magdeburg). TD: MZPW.

Host plants. Salicaceae: *Populus acuminata* Rydberg, *P. alba* L., *P. deltoides* Marshall, *P. grandidentata* Michaux, *P. nigra* L., *P. tremula* L., *Salix* sp. (Medvedev and Rogynskaya 1988; Bukejs 2009; Sergeev and Legalov 2022).

Remarks. The external male genitalia of this species differ from those of other species of the subgenus *Zeugophora* (*Zeugophora*) in having the dorso-central portion without a sclerite (Fig. 18).

Zeugophora (*Zeugophora*) *turneri* Power, 1863

Figs 21–24

Zeugophora turneri Power, 1863, 21: 8735. TL unknown. TD unknown.
Zeugophora rufotestacea Kraatz, 1871, 15: 162.

Host plant. Salicaceae: *Populus* sp. (Bukejs 2009).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Zeugophora*) *cribrata* and *Z.* (*Z.*) *cyanea* in the dorso-central

portion of median lobe with a sclerite, but differ in having apex of median lobe gradually narrowed (apex of median lobe abruptly narrowed in *Z.* (*Z.*) *cribrata* and *Z.* (*Z.*) *cyanea*).

Subgenus *Pedrillia* Westwood, 1864

External male genitalia. (Figs 25–83, 92–99) Median lobe sclerotized, slender or short and broad, curved in lateral view, sides generally thickened, dorso-central portion entirely membranous, sides parallel or diamond-shaped, or dorso-central portion membranous with basal 1/3 tubular, sides parallel, apex generally strongly protruding, blunt or sharp; median struts rod-shaped, widely separated from each other, ~1.5–3.3× as long as median lobe; base of tegmen Y- or V-shaped, basal piece generally short, tegminal ring with base generally narrower than apical portion, paramere generally tongue-shaped or sub-trapezoid, apical margin with setae; endophallus membranous, with a paired granulated area. Spiculum long, basal part long, apex trifid or not, sclerotized.

Zeugophora (*Pedrillia*) *annulata* (Baly, 1873)

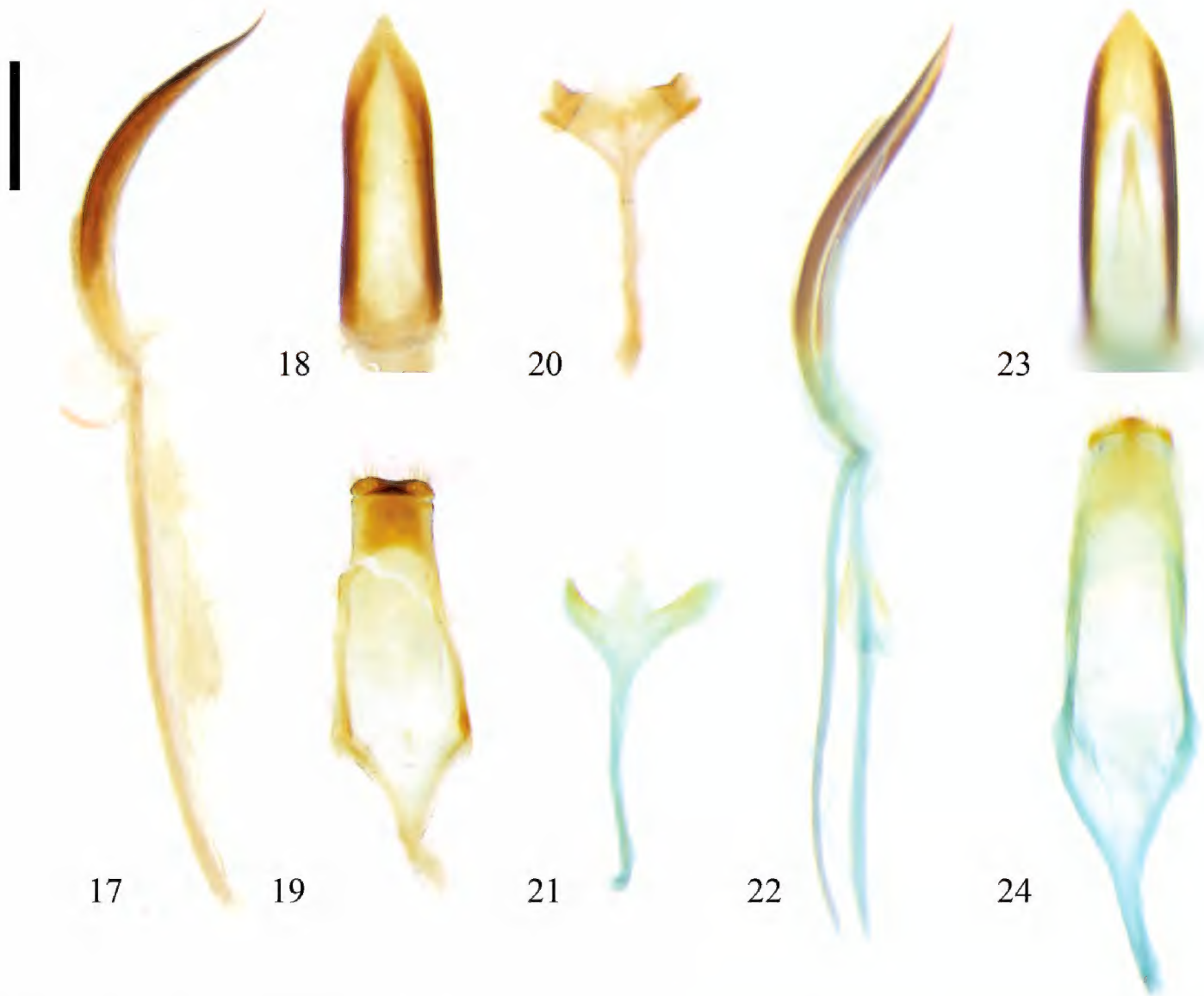
Figs 25–28

Pedrillia annulata Baly, 1873: 79. TL: Japan. TD: NHMUK.
Pedrillia annulata var. *disconotata* Pic, 1906: 27. Synonymized by Ohno 1961: 37.
Pedrillia annulata ab. *theresae* Pic, 1945: 13.
Zeugophora annulata: Gressitt, 1945: 137.
Zeugophora (*Pedrillia*) *annulata*: Jolivet, 1957: 12.
Pedrillia annulata f. *inannulata* Chûjô, 1959: 1.
Pedrillia annulata f. *melanaria* Chûjô, 1959: 1.
Pedrillia biguttata Kraatz, 1879a: 119. Synonymized by Ohno, 1961: 37.
Pedrillia annulata f. *biguttata*: Ohno, 1961: 37.

Host plants. Celastraceae: *Euonymus alatus* (Thunb.) Siebold, *Euonymus przewalskii* Maxim., *Euonymus phellomanus* Loes. ex Diels., *Euonymus maacki* Rupr., and *Euonymus sacrosancta* Koidz. (Medvedev and Roginskaya 1988; Takemoto 2019; pers. obs.).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *bicolor* and *Z.* (*P.*) *tricolor* in having the median lobe long and arched in lateral view, and the shapes of median lobe, tegmen, and spiculum. This species differs from *Z.* (*P.*) *bicolor* in having the apex of the median lobe slightly narrower, not bending / curving leftwards, basal piece of tegmen shorter (apex of median lobe slightly broader, tending slightly leftwards, basal piece of tegmen longer in *Z.* (*P.*) *bicolor*, Figs 31, 32). This species differs from *Z.* (*P.*) *tricolor* in having the apex of the median lobe slightly longer and sharper (apex of median lobe slightly shorter and blunt in *Z.* (*P.*) *tricolor*, Fig. 70).

Figures 9–16. Male genitalia of *Zeugophora* (*Zeugophora*) species. **9–12.** *Z.* (*Z.*) *cyanea* Chen, 1974; **9.** Median lobe and median struts, lateral view; **10.** Median lobe, dorsal view; **11.** Tegmen, dorsal view; **12.** Spiculum, dorsal view; **13–16.** *Z.* (*Z.*) *nigroaerea* Lopatin, 2008; **13.** Spiculum, dorsal view; **14.** Median lobe and median struts, lateral view; **15.** Median lobe, dorsal view; **16.** Tegmen, dorsal view. Scale bar: 0.2 mm.



Figures 17–24. Male genitalia of *Zeugophora* (*Zeugophora*) species. **17–20.** *Z.* (*Z.*) *scutellaris* Suffrian, 1840; **17.** Median lobe and median struts, lateral view; **18.** Median lobe, dorsal view; **19.** Tegmen, dorsal view; **20.** Spiculum, dorsal view; **21–24.** *Z.* (*Z.*) *turneri* Power, 1863; **21.** Spiculum, dorsal view; **22.** Median lobe and median struts, lateral view; **23.** Median lobe, dorsal view; **24.** Tegmen, dorsal view. Scale bar: 0.2 mm.

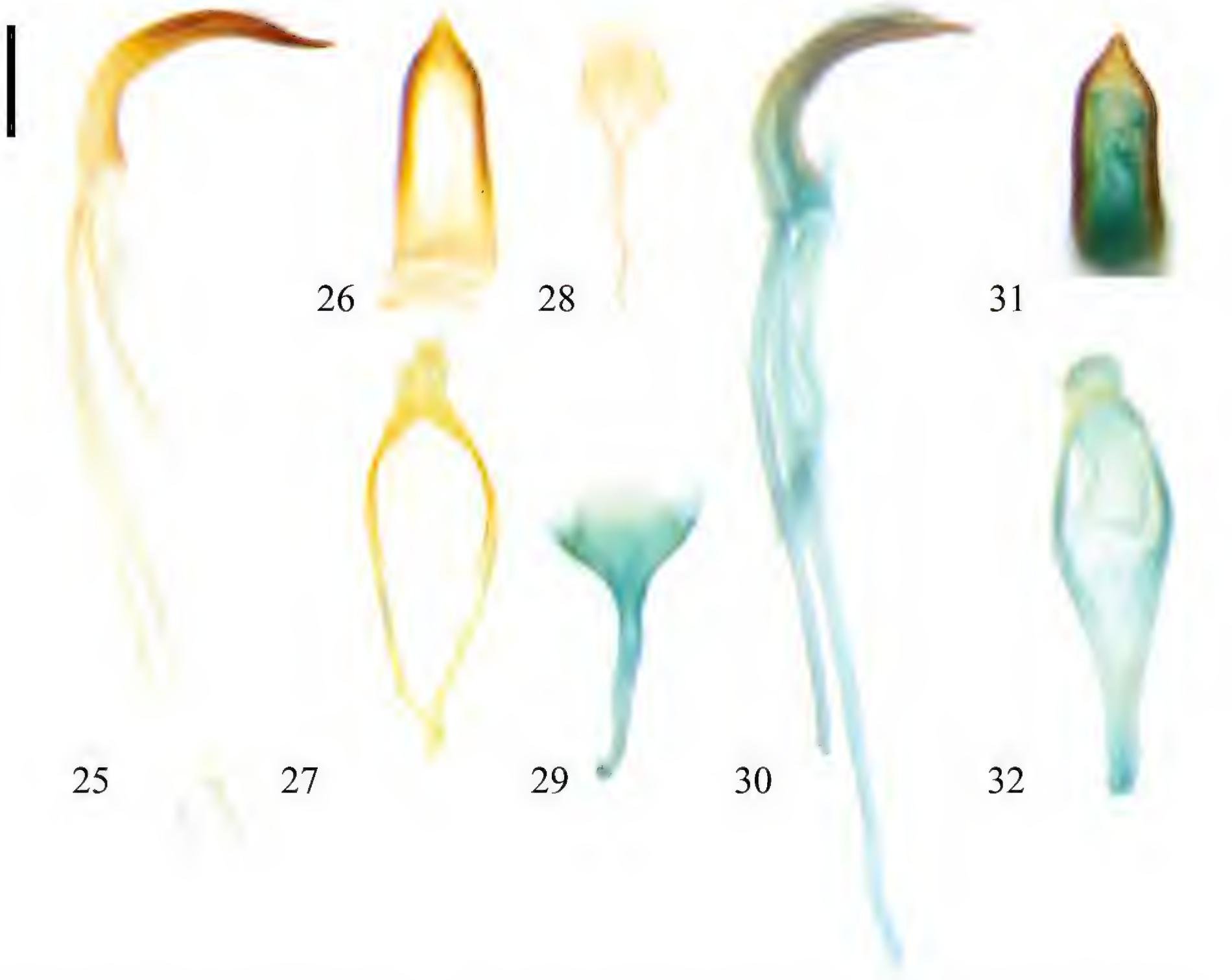
***Zeugophora* (*Pedrillia*) *bicolor* (Kraatz, 1879)**
Figs 29–32

Pedrillia bicolor Kraatz, 1879a: 120. TL: Russia (Amur). TD: SDEI.
Pedrillia nigricollis Jacoby, 1885: 195. Synonymized by Kimoto 1986: 309.
Zeugophora bicolor: Gressitt 1945: 139.
Zeugophora (*Pedrillia*) *bicolor*: Jolivet 1957: 12.

Host plant. Celastraceae: *Celastrus orbiculatus* Thunb. (pers. obs.).

Remarks. The similarities and differences of external male genitalia between this species and *Zeugophora* (*Pedrillia*) *annulata* are provided in the remarks under *Z.* (*P.*) *annulata*.

The external male genitalia of this species are also similar to *Zeugophora* (*Pedrillia*) in having the median lobe long and arched in lateral view, and the shapes of the median lobe, tegmen, and spiculum, but differs from it in having the apex of the median lobe longer and narrower (apex of median lobe shorter and broader in *Z.* (*P.*) *tricolor*, Fig. 70).



Figures 25–32. Male genitalia of *Zeugophora* (*Pedrillia*) species. **25–28.** *Z.* (*P.*) *annulata* (Baly, 1873); **25.** Median lobe and median struts, lateral view; **26.** Median lobe, dorsal view; **27.** Tegmen, dorsal view; **28.** Spiculum, dorsal view; **29–32.** *Z.* (*P.*) *bicolor* (Kraatz, 1879); **29.** Spiculum, dorsal view; **30.** Median lobe and median struts, lateral view; **31.** Median lobe, dorsal view; **32.** Tegmen, dorsal view. Scale bar: 0.2 mm.

Zeugophora (*Pedrillia*) *dimorpha* Gressitt, 1945

Figs 33–36

Zeugophora dimorpha Gressitt, 1945: 138, pl. 6, figs 6, 9. TL: China: (Jiangxi, Guangdong). TD: CAS.
Zeugophora (*Pedrillia*) *dimorpha*: Jolivet 1957: 12.

Host plant. Unknown.

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *yunnanica* Chen & Pu and *Z.* (*P.*) *trifasciata* Li & Liang in shape, but differ from *Z.* (*P.*) *yunnanica* in having the median lobe more slender, the sides of the spiculum longer than the central portion (median lobe shorter and broader, the central portion of spiculum longer than sides in *Z.* (*P.*) *yunnanica*, Figs 80, 82), differ from *Z.* (*P.*) *trifasciata* in having the sclerite of median lobe dorso-central slightly sclerotized and the sides of the spiculum longer than the central portion (strongly sclerotized and the central portion of spiculum longer than sides in *Z.* (*P.*) *trifasciata*).

Zeugophora (*Pedrillia*) *emeica* Li & Liang, 2018

Figs 37–40

Zeugophora (*Pedrillia*) *emeica* Li & Liang, 2018: 135. TL: China (Sichuan). TD: IZCAS.

Host plant. Unknown.

Remarks. The external male genitalia of this species are similar to that of *Zeugophora* (*Pedrillia*) *nigroapica* in having the base and apex of the median lobe narrow, but differ in having the base of the median lobe broader, apex strongly narrowed and downward, median strut short, tegmen strongly sclerotized (median lobe elongate, apex slightly swollen laterally, median struts long, tegmen slightly sclerotized in *Z.* (*P.*) *nigroapica*, Figs 64–66).

Zeugophora (*Pedrillia*) *euonymorum* Li & Liang, 2020

Figs 41–44

Zeugophora (*Pedrillia*) *euonymorum* Li & Liang, 2020, ZooKeys, 975: 57–61, figs 12–28. TL China: Ningxia. TD: KIZ, IZCAS.

Host plants. Celastraceae: *Euonymus alatus* (Thunb.) Siebold, *E. hamiltonianus* Wall. (Li and Liang 2020).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *annulata*, *Z.* (*P.*) *bicolor*, *Z.* (*P.*) *tricolor*, but differ from them in having a slightly flattened and less curved median lobe in the lateral view, the apex of the median lobe shorter and slightly broader.

Zeugophora (*Pedrillia*) *flavithorax* Li & Liang, 2020

Figs 45–48

Zeugophora (*Pedrillia*) *flavithorax* Li & Liang, 2020, ZooKeys, 975: 61–66, figs 29–37, 46–47. TL China: Guizhou. TD: KIZ, IZCAS.

Host plant. Symplocaceae (Li and Liang 2020).

Remarks. The external male genitalia of this species differ from those of other species of *Zeugophora* (*Pedrillia*) in having the median lobe apex slightly broad and the apical margin projecting.

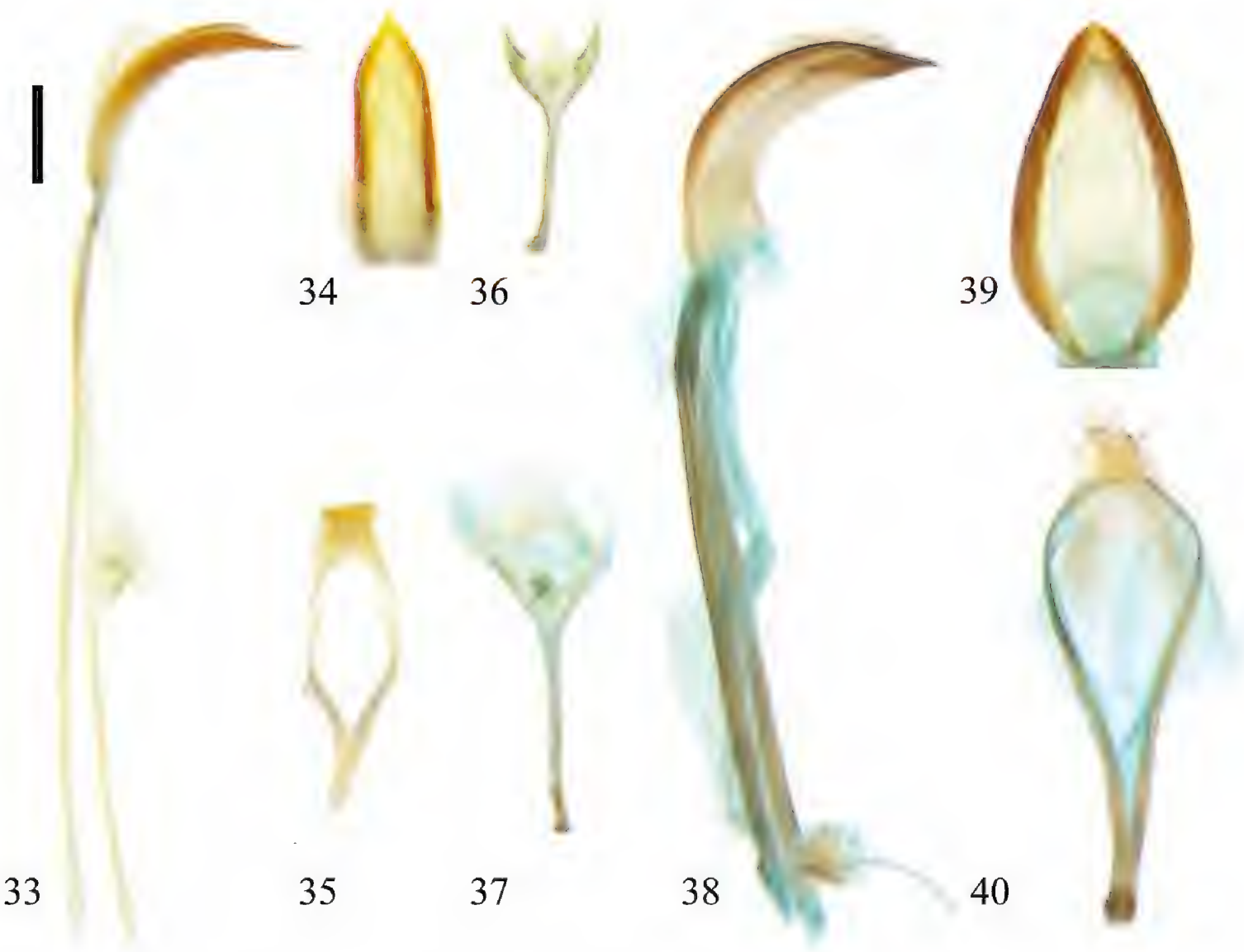
Zeugophora (*Pedrillia*) *indica* Jacoby, 1903

Figs 49–52

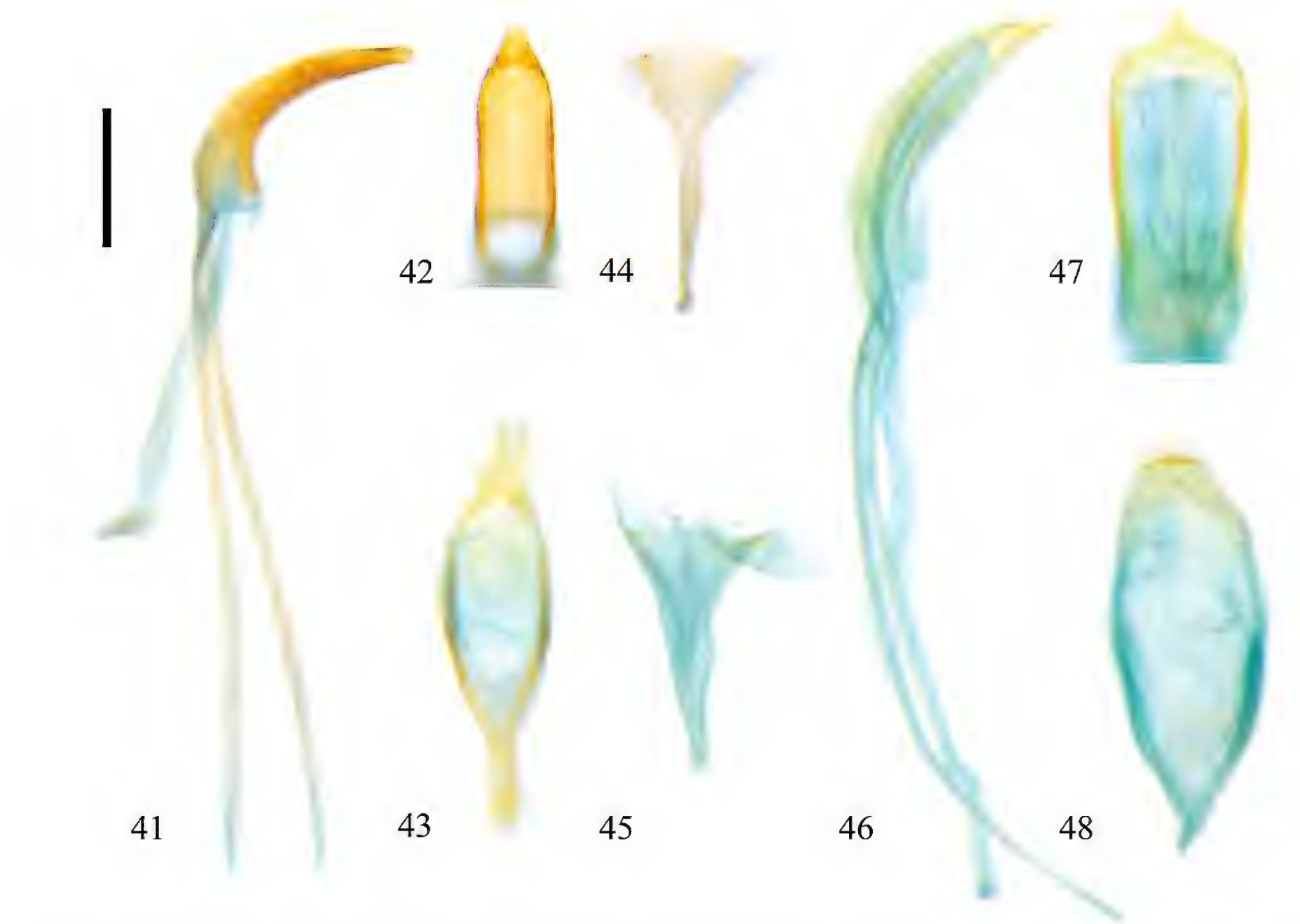
Zeugophora indica Jacoby, 1903: 81–82. TL: India (Nilgiri). TD: NHMUK.
Pedrillia flavipes Jacoby, 1908: 14. Synonymized by Bryant 1943: 246.
Auehenia (*Pedrillia*) *indica*: Monrós 1959: 23.
Zeugophora (*Pedrillia*) *indica*: Kimoto & Gressitt 1979: 205.

Host plant. Possibly Lamiaceae: *Vitex quinata* (Lour.) Will. (pers. obs.).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *annulata* and *Z.* (*P.*) *bicolor* in that the basal 1/3 of the median



Figures 33–40. Male genitalia of *Zeugophora* (*Pedrillia*) species. **33–36.** *Z.* (*P.*) *dimorpha* Gressitt, 1945; **33.** Median lobe and median struts, lateral view; **34.** Median lobe, dorsal view; **35.** Tegmen, dorsal view; **36.** Spiculum, dorsal view; **37–40.** *Z.* (*P.*) *emeica* Li & Liang, 2018; **37.** Spiculum, dorsal view; **38.** Median lobe and median struts, lateral view; **39.** Median lobe, dorsal view; **40.** Tegmen, dorsal view. Scale bar: 0.2 mm.



Figures 41–48. Male genitalia of *Zeugophora* (*Pedrillia*) species. **41–44.** *Z.* (*P.*) *euonymorum* Li & Liang, 2020; **41.** Median lobe and median struts, lateral view; **42.** Median lobe, dorsal view; **43.** Tegmen, dorsal view; **44.** Spiculum, dorsal view; **45–48.** *Z.* (*P.*) *flavithorax* Li & Liang, 2020; **45.** Spiculum, dorsal view; **46.** Median lobe and median struts, lateral view; **47.** Median lobe, dorsal view; **48.** Tegmen, dorsal view. Scale bar: 0.2 mm.

lobe is tubular, but differs in having the apex of the median lobe broader and slightly curved in lateral view, the median struts > 3 per median lobe (apex of median lobe narrower, median lobe curved in lateral view, and the median struts < 3 per median lobe in *Z.* (*P.*) *annulata* and *Z.* (*P.*) *bicolor*, Figs 25–26, 30–31, respectively).

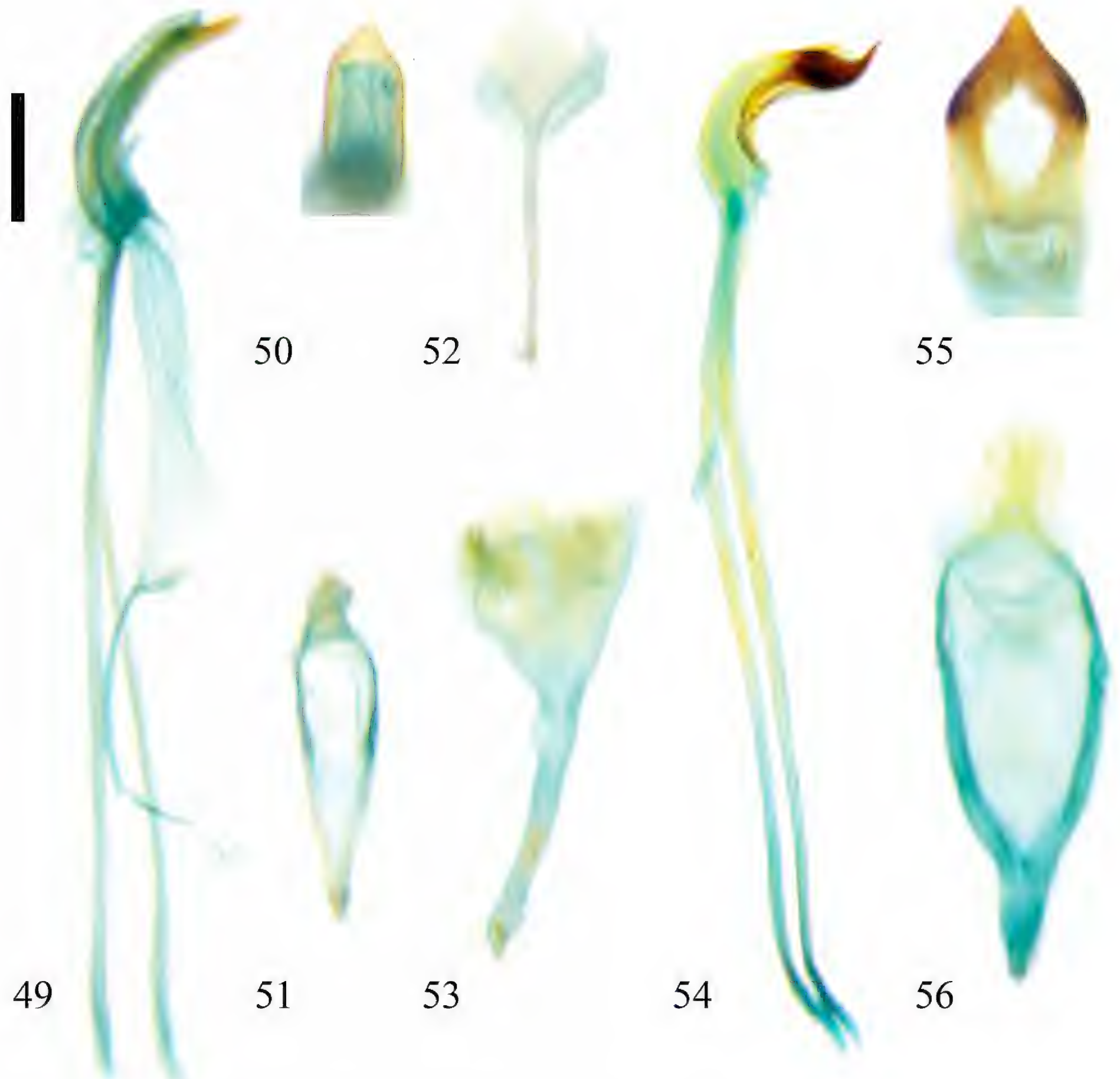
Zeugophora (*Pedrillia*) *longicornis* (Westwood, 1864)

Figs 53–56

Pedrillia longicornis Westwood, 1864: 280. TL: India (Bombay). TD: NHMUK.
Zeugophora andrewesi Jacoby, 1903: 82. Synonymized by Bryant 1943: 246.
Zeugophora longicornis: Bryant 1943: 246.
Zeugophora (*Pedrillia*) *longicornis*: Kimoto & Gressitt 1979: 205.

Host plant. Lamiaceae: *Vitex quinata* (Lour.) Will. (pers. obs.).

Remarks. The external male genitalia of this species differ from all other species of *Zeugophora* (*Pedrillia*) in having the median lobe short and broad, strongly curved in lateral view, apical portion strongly upward curved, apex sharp (Figs 54–55).



Figures 49–56. Male genitalia of *Zeugophora* (*Pedrillia*) species. **49–52.** *Z.* (*P.*) *indica* Jacoby, 1903; **49.** Median lobe and median struts, lateral view; **50.** Median lobe, dorsal view; **51.** Tegmen, dorsal view; **52.** Spiculum, dorsal view; **53–56.** *Z.* (*P.*) *longicornis* (Westwood, 1864); **53.** Spiculum, dorsal view; **54.** Median lobe and median struts, lateral view; **55.** Median lobe, dorsal view; **56.** Tegmen, dorsal view. Scale bar: 0.2 mm.

***Zeugophora* (*Pedrillia*) *maculata* Chûjô, 1941**

Figs 57–59

Zeugophora maculata, Chûjô, 1941: 463, 499. TL: China (Taiwan). TD: unknown.

Host plant. Symplocaceae: *Symplocos sumuntia* Buch.-Ham. ex D. Don (pers. obs.).

Remarks. The external male genitalia of this species differ from other species of *Zeugophora* (*Pedrillia*) in having the apical margin of median lobe blunt and medially downward (Figs 57–58).

Zeugophora (*Pedrillia*) *nigricollis* (Jacoby, 1885)

Figs 60–63

Pedrillia nigricollis Jacoby, 1885: 195. TL: Japan, Wada-tôge. TD: NHMUK. Synonymized as *Pedrillia bicolor* Kraatz, 1879a: 120 by Kimoto 1986: 309.

Zeugophora (*Pedrillia*) *nigricollis*: Crowson 1946: 95; Gressitt & Kimoto 1961: 24, 27; Chûjô 1954: 51; Chûjô & Kimoto 1961: 119; Kimoto 1964: 108.

Zeugophora (*Pedrillia*) *bicolor*: Kimoto 1986: 309; Jolivet 1957: 12; Kimoto & Takizawa 1994: 6, 99, 267; An & Kwon 2002: 272; Silfverberg 2010: 334; Li & Liang 2018: 133.

Zeugophora bicolor: Gressitt 1945: 139; An & Kwon 1995: 91–92; Takizawa 2006: 2; Rodríguez-Mirón 2018: 291.

Zeugophora nigricollis (Jacoby, 1885). Restored as a valid species by Takemoto 2019: 15–19.

Host plants. Celastraceae: *Euonymus sieboldiana* Blum., *Euonymus alatus* (Thunb.) Siebold (Takemoto 2019; Li and Liang 2020).

Remarks. The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *annulata*, *Z.* (*P.*) *bicolor*, *Z.* (*P.*) *tricolor*, and *Z.* (*P.*) *euonymorum*, but differ from *Z.* (*P.*) *annulata*, *Z.* (*P.*) *bicolor*, and *Z.* (*P.*) *tricolor* in having the median lobe less curved in the lateral view and slender, with the apex of the median lobe triangular and blunt; genitalia differ from that of *Z.* (*P.*) *euonymorum* in having the median lobe slender and the apex slightly narrower.

Zeugophora (*Pedrillia*) *nigroapica* Li & Liang, 2018

Figs 64–67

Zeugophora (*Pedrillia*) *nigroapica* Li & Liang, 2018: 143. TL: China (Yunnan). TD: IZCAS.

Host plant. Unknown.

Remarks. The similarities and differences of external male genitalia between this species and *Zeugophora* (*Pedrillia*) *emeica* Li & Liang are presented in the remarks of *Z.* (*P.*) *emeica*. The external male genitalia of this species differ from other species of the subgenus *Pedrillia* except that of *Z.* (*P.*) *emeica* in having a sub-oval median lobe.

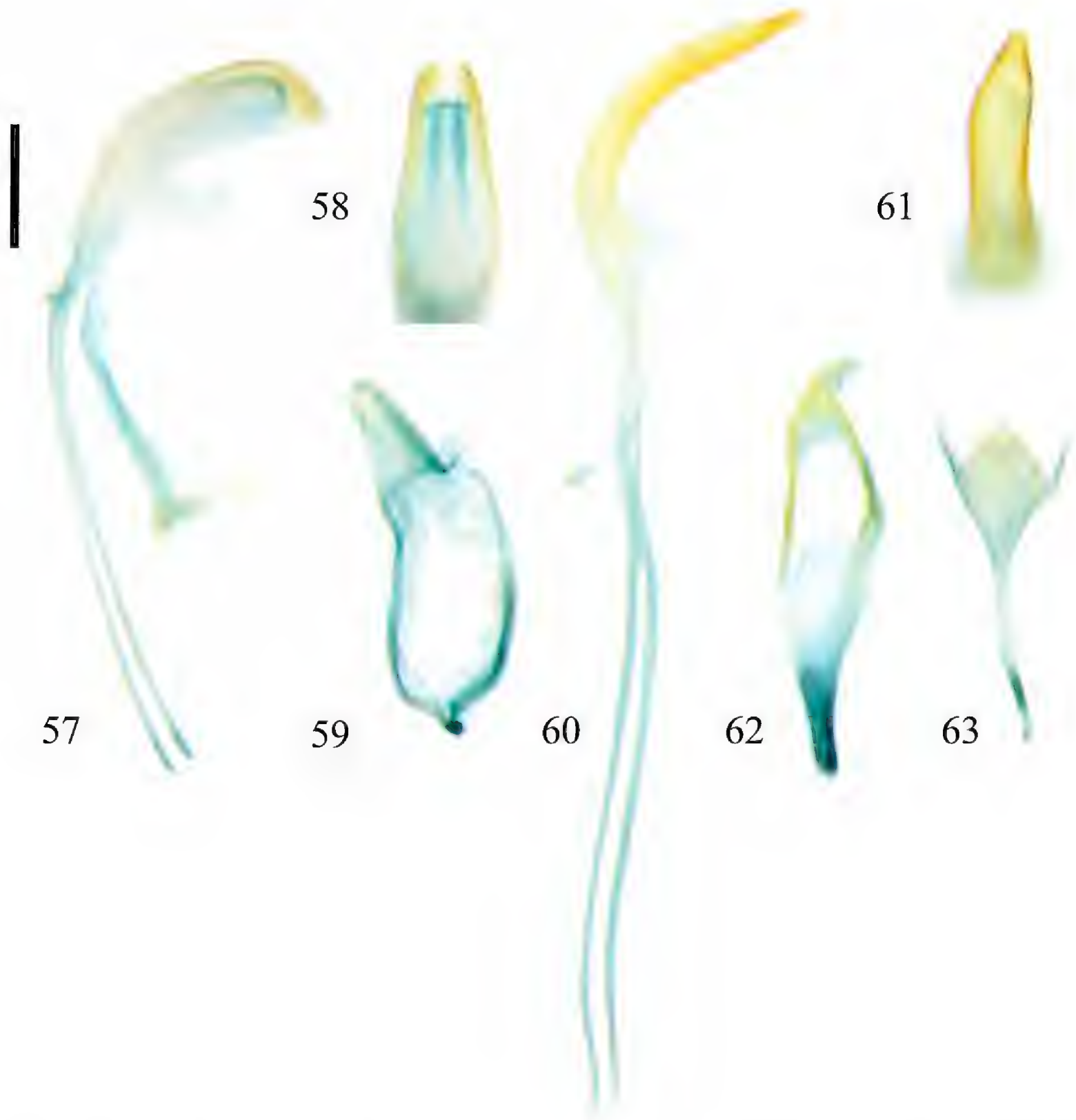
Zeugophora (*Pedrillia*) *tricolor* Chen & Pu, 1962

Figs 68–71

Zeugophora (*Pedrillia*) *tricolor* Chen & Pu, 1962: 116, fig. 2. TL: China (Gansu). TD: IZCAS.

Host plant. Celastraceae: *Euonymus alatus* (Thunb.) Siebold (pers. obs.).

Remarks. The similarities and differences of external male genitalia of this species, *Zeugophora* (*Pedrillia*) *annulata*, and *Z.* (*P.*) *bicolor* are described in the remarks under *Z.* (*P.*) *annulata* and *Z.* (*P.*) *bicolor*.



Figures 57–63. Male genitalia of *Zeugophora* (*Pedrillia*) species. **57–59.** *Z.* (*P.*) *maculata* Chûjô, 1941; **57.** Median lobe and median struts, lateral view; **58.** Median lobe, dorsal view; **59.** Tegmen, dorsal view; **60–63.** *Z.* (*P.*) *nigricollis* (Jacoby, 1885); **60.** Median lobe and median struts, lateral view; **61.** Median lobe, dorsal view; **62.** Tegmen, dorsal view; **63.** Spiculum, dorsal view. Scale bar: 0.2 mm.

Zeugophora (*Pedrillia*) *trifasciata* Li & Liang, 2020

Figs 72–75

Zeugophora (*Pedrillia*) *trifasciata* Li & Liang, 2020, ZooKeys, 975: 69–72, figs 58–66. TL: China: Yunnan. TD: KIZ.

Host plant. Unknown.

Remarks. The similarities and differences of external male genitalia between this species and *Zeugophora* (*Pedrillia*) *dimorpha* are described in the remarks under *Z.* (*P.*) *dimorpha*.

The external male genitalia of this species are similar to that of *Zeugophora* (*Pedrillia*) *yunnanica* Chen & Pu in shape, but differ in having the median lobe dorso-central with a strongly sclerotized sclerite (without a strongly sclerotized sclerite in *Z.* (*P.*) *yunnanica*, Fig. 82).

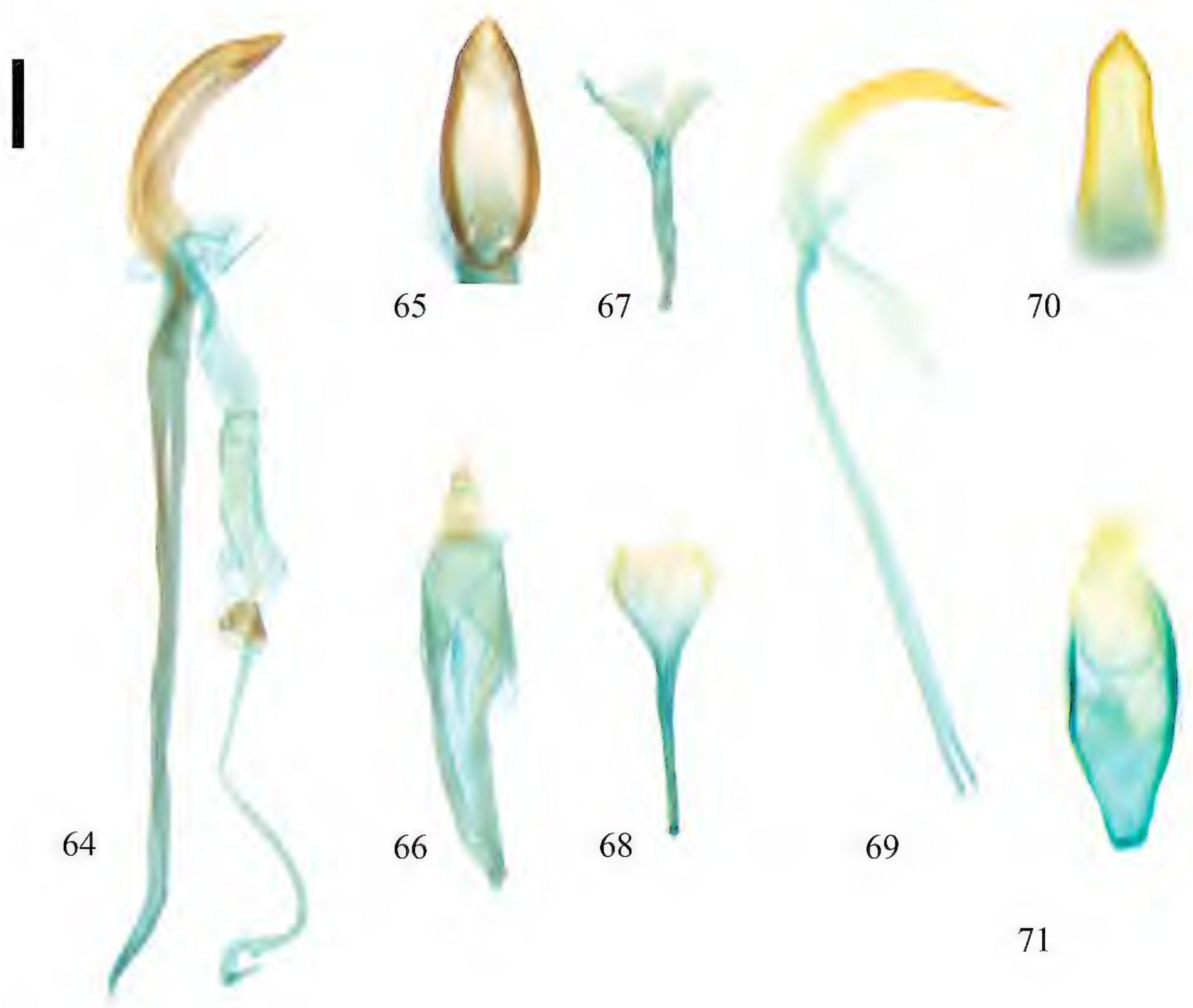


Figure 64–71. Male genitalia of *Zeugophora* (*Pedrillia*) species. **64–67.** *Z.* (*P.*) *nigroapica* Li & Liang, 2018; **64.** Aedeagus, lateral view; **65.** Median lobe, dorsal view; **66.** Tegmen, dorsal view; **67.** Spiculum, dorsal view; **68–71.** *Z.* (*P.*) *tricolor* Chen & Pu, 1962; **68.** Spiculum, dorsal view; **69.** Median lobe and median struts, lateral view; **70.** Median lobe, dorsal view; **71.** Tegmen, dorsal view. Scale bar: 0.2 mm.

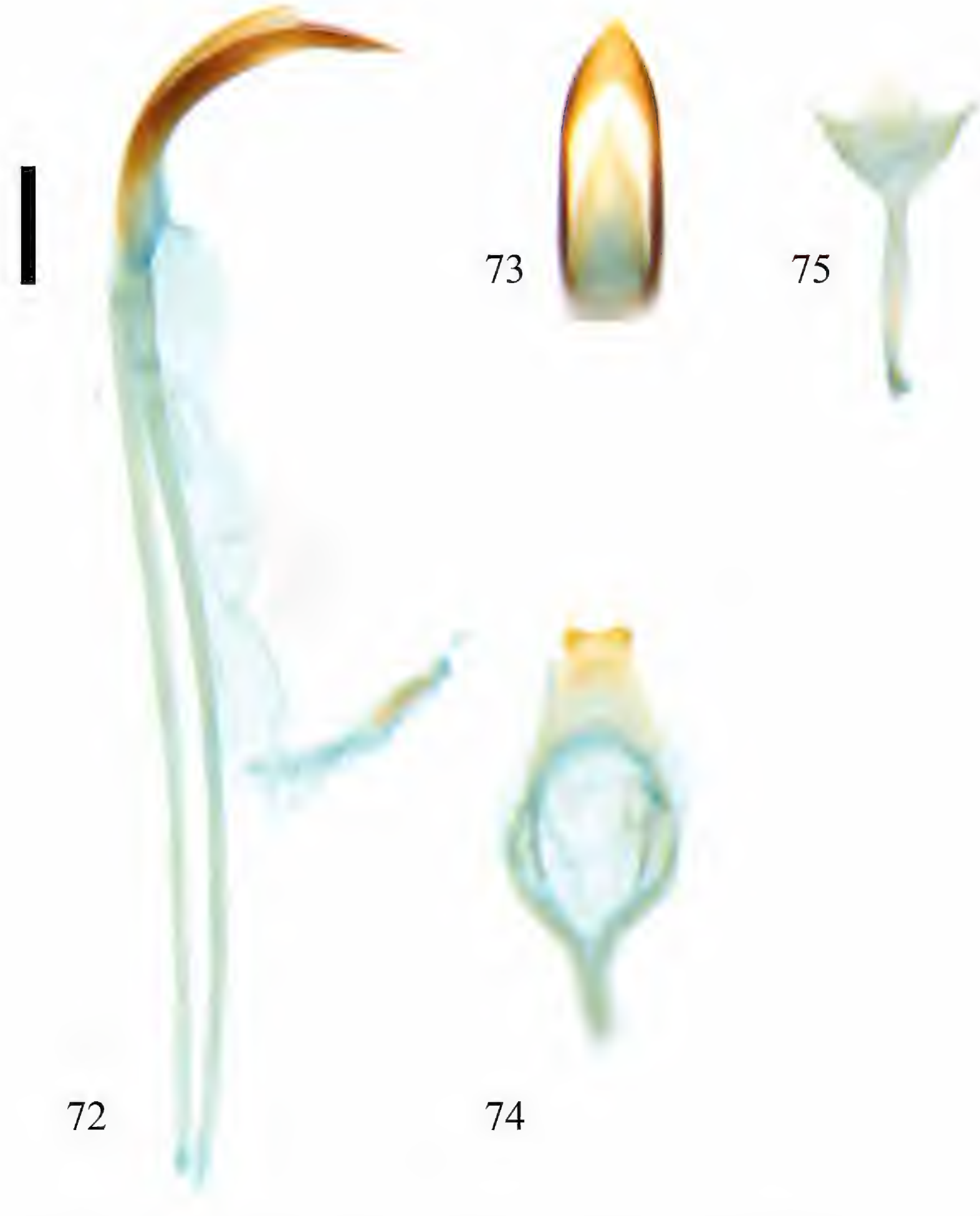
Zeugophora (*Pedrillia*) *yuae* Li & Liang, 2020

Figs 76–79

Zeugophora (*Pedrillia*) *yuae* Li & Liang, 2020, ZooKeys, 975: 72–76, figs 67–79.
TL China: Yunnan. TD: KIZ, IZCAS.

Host plant. Lamiaceae: *Vitex quinata* (Lour.) Will. (Li and Liang 2020).

Remarks. The external male genitalia of this species are similar to that of *Zeugophora* (*Pedrillia*) *tricolor* in shape, but differ in having the median lobe less curved in the lateral view, the apex of the median lobe slightly broader and blunt, and the ratio of median struts / median lobe ~3.5 (the median lobe is more curved in the lateral view, the apex of the median lobe slightly narrower and sharper, and the ratio of median struts / median lobe is ~2.2 in *Z.* (*P.*) *tricolor*).



Figures 72–75. Male genitalia of *Zeugophora* (*Pedrillia*) *trifasciata* Li & Liang, 2020. **72.** Median lobe and median struts, lateral view; **73.** Median lobe, dorsal view; **74.** Tegmen, dorsal; **75.** Spiculum, dorsal view. Scale bar: 0.2 mm.

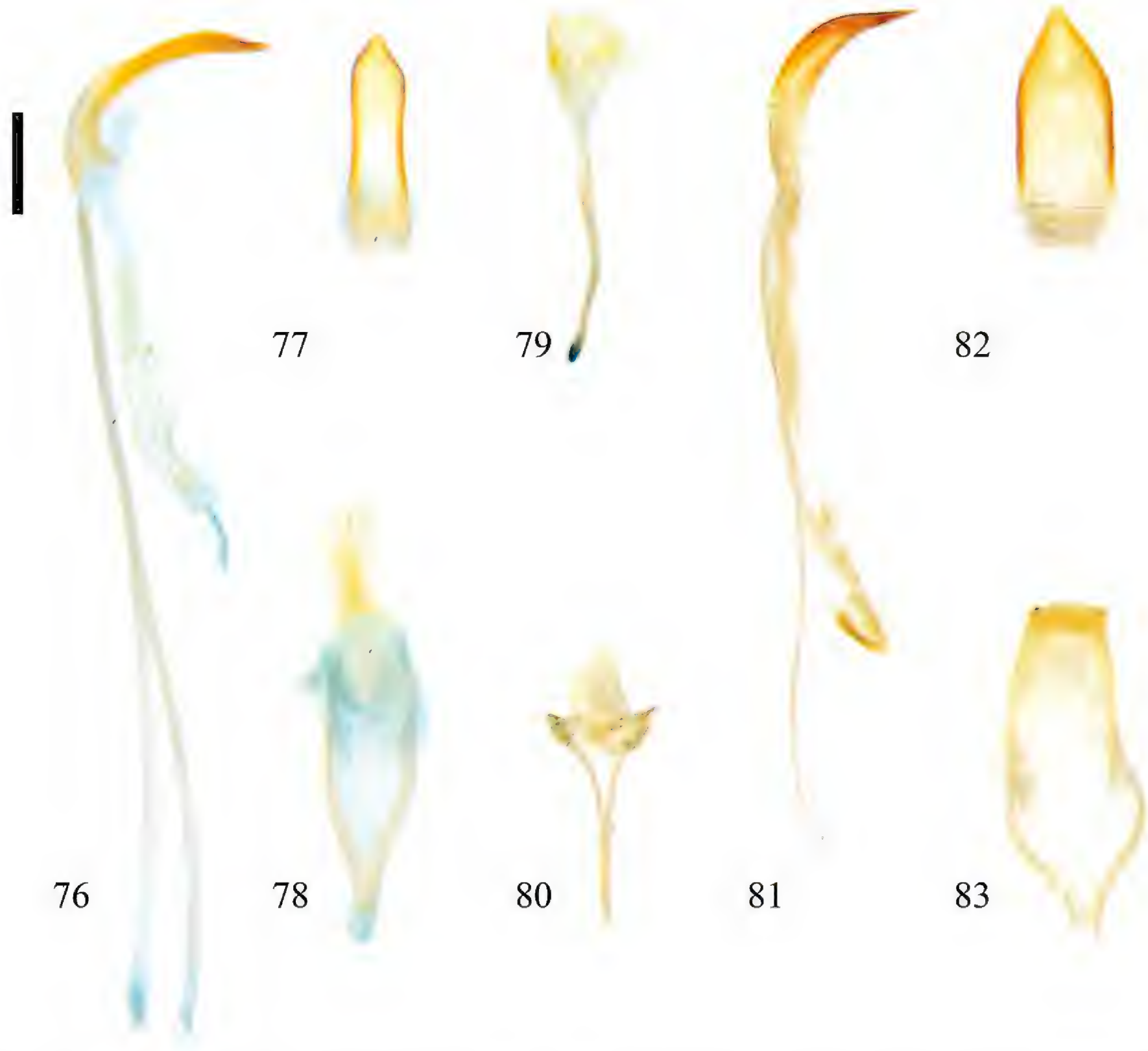
Zeugophora (*Pedrillia*) *yunnanica* Chen & Pu, 1962

Figs 80–83

Zeugophora (*Pedrillia*) *yunnanica* Chen & Pu, 1962: 116, fig. 3. TL: China (Yunnan). TD: IZCAS.

Host plant. Symplocaceae: *Symplocos* sp. (Chen and Pu 1962).

Remarks. The similarities and differences of external male genitalia of this species, *Zeugophora* (*Pedrillia*) *dimorpha*, and *Z.* (*P.*) *trifasciata* are presented in the remarks under *Z.* (*P.*) *dimorpha* and *Z.* (*P.*) *trifasciata*.



Figures 76–83. Male genitalia of *Zeugophora* (*Pedrillia*) species. **76–79.** *Z.* (*P.*) *yuae* Li & Liang, 2020; **76.** Median lobe and median struts, lateral view; **77.** Median lobe, dorsal view; **78.** Tegmen, dorsal view; **79.** Spiculum, dorsal view; **80–83.** *Z.* (*P.*) *yunnanica* Chen & Pu, 1962; **80.** Spiculum, dorsal view; **81.** Median lobe and median struts, lateral view; **82.** Median lobe, dorsal view; **83.** Tegmen, dorsal view. Scale bar: 0.2 mm.

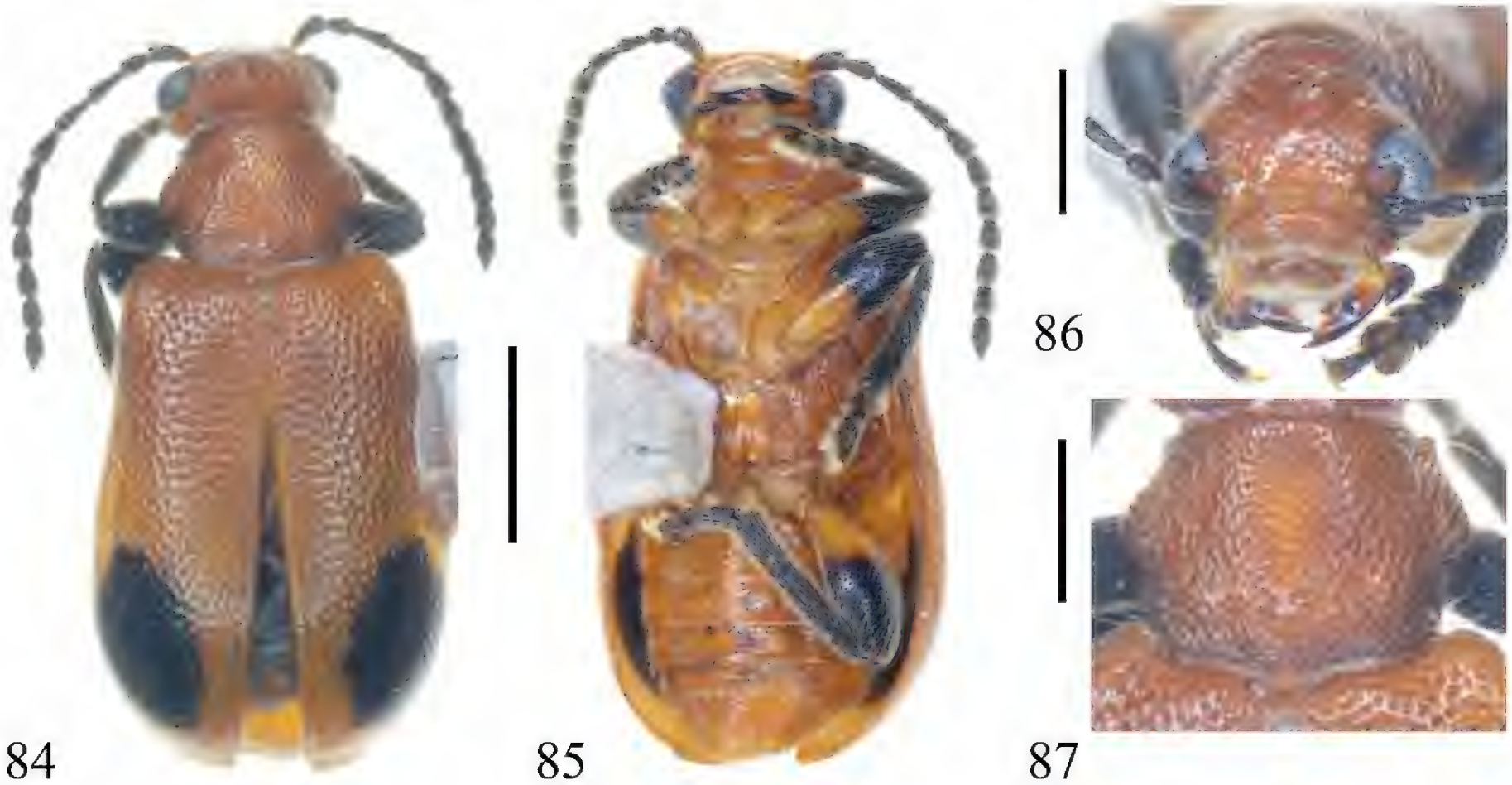
***Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov.**

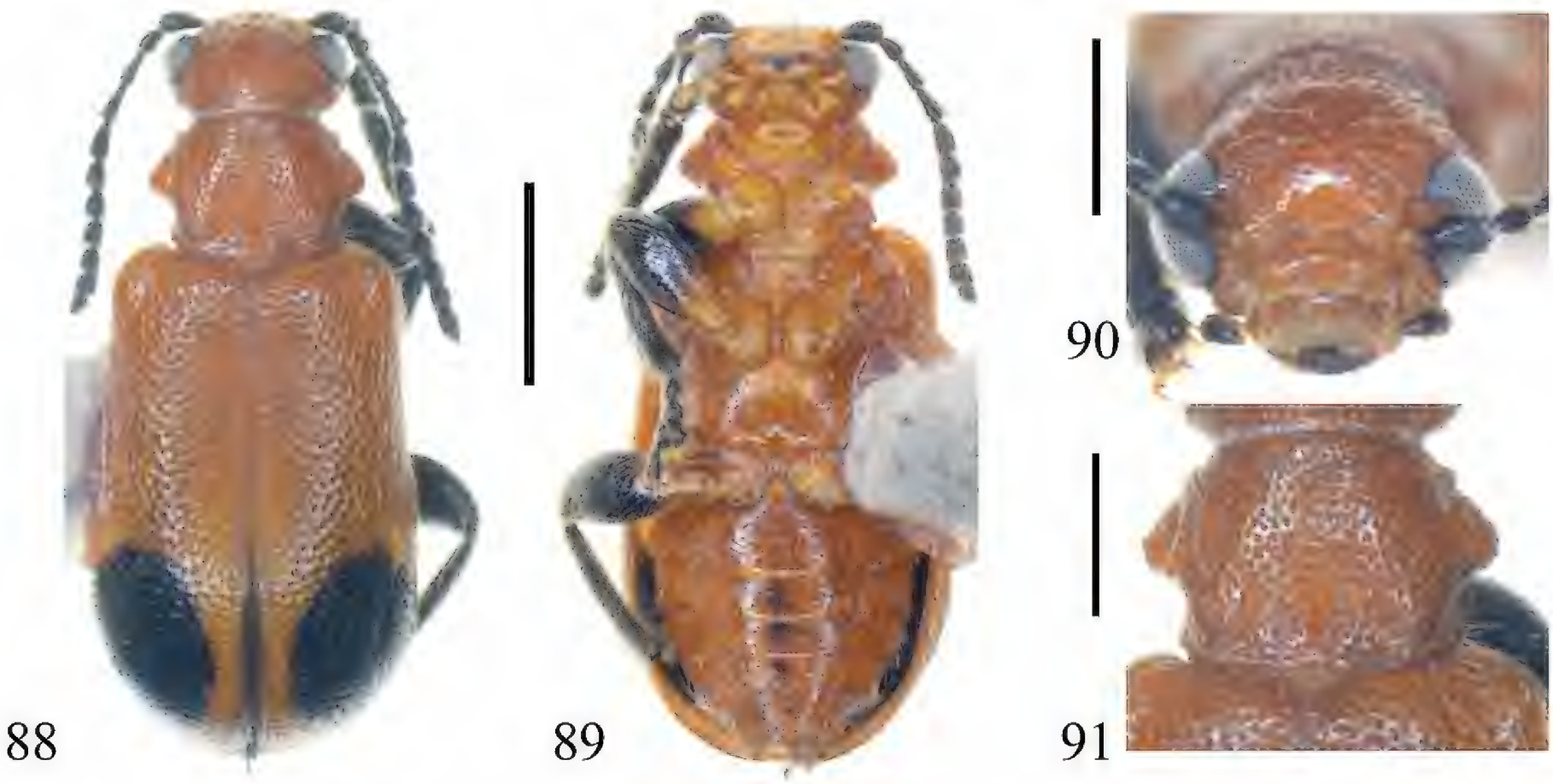
https://zoobank.org/1751E637-1A2B-4A46-8740-B2AC4DCD64E8

Suggested Chinese name 六盘山小距甲

Figs 84–106

Specimens examined. ***Holotype*** (KIZ): male, China, Ningxia, Jingyuan, Liupan Shan National Nature Reserve, Danangou, 35.48659°N, 106.27045°E / 2130 m, 2018.vii.28, Kaiqin Li coll., Kunming Institute of Zoology, Chinese Acad. Sci. / Holotype, *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov., des. by K.Q. Li & H.B. Liang, 2024 [red label]. ***Paratype*** (IZCAS): 1 male, China, Ningxia, Jingyuan, Liupan Shan National Nature Reserve, Longtan Forest Farm, 35.39160°N, 106.35299°E / 1918 m, 2018.vii.26, Kaiqin Li & Likun Zhang coll., Kunming Institute of Zoology, Chinese Acad. Sci. / Paratype, *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov., des. by K.Q. Li & H.B. Liang, 2024 [yellow label].



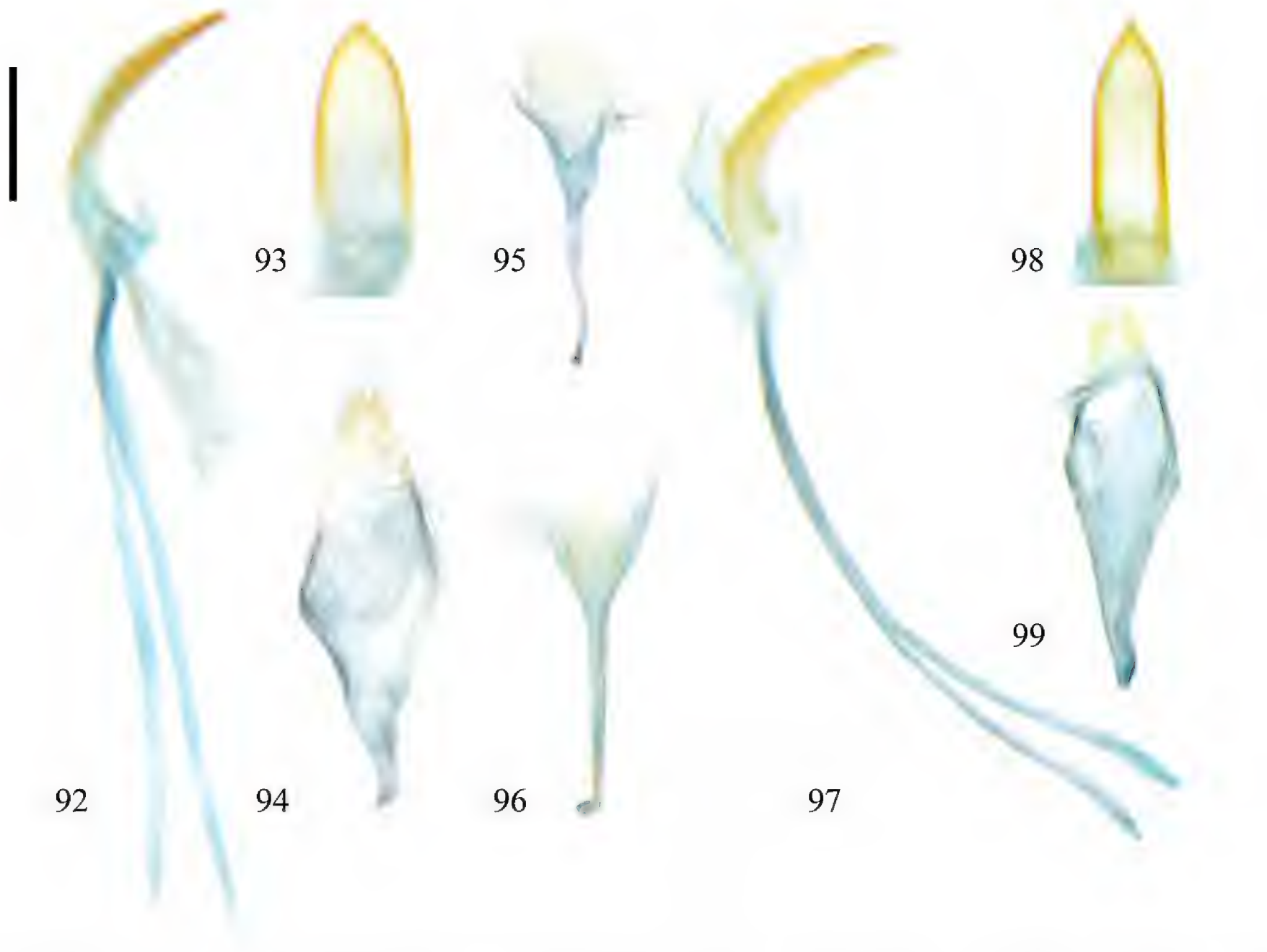


Figures 84–91. Holotype and paratype of *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov. **84–87.** Holotype, male; **84.** Dorsal view; **85.** Ventral view; **86.** Head, anterior view; **87.** Pronotum, dorsal view; **88–91.** Paratype, male; **88.** Dorsal view; **89.** Ventral view; **90.** Head, anterior view; **91.** Pronotum, dorsal view. Scale bars: 1.0 mm (**84, 85, 88, 89**); 0.5 mm (**86, 87, 90, 91**).

Diagnosis. Head brown, pronotum, scutellum, and underside brown; elytra brown, posterior portion with two black spots; antennae black; legs brown with posterior portion black; antennomeres 3 and 4 long, 5–11 short; apex of median lobe triangular and narrow.

Description. BL = 3.8 mm, BW = 1.7 mm. Head brown, except posterior portion of mandible black; pronotum, scutellum, and underside brown; elytra brown, but with two black spots posteriorly; antennae black; legs brown but distal femora, tibiae, and tarsi black.

Head: eye prominent, inner margin with distinct canthus; vertex sparsely punctate and pubescent centrally, densely punctate and pubescent laterally;



Figures 92–99. Holotype and paratype of *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov. **92–95.** Male genitalia of holotype; **92.** Median lobe and median struts, lateral view; **93.** Median lobe, dorsal view; **94.** Tegmen, dorsal view; **95.** Spiculum, dorsal view; **96–99.** Male genitalia of paratype; **96.** Spiculum, dorsal view; **97.** Median lobe and median struts, lateral view; **98.** Median lobe, dorsal view; **99.** Tegmen, dorsal view. Scale bar: 0.2 mm.

occiput strongly constricted; frons sparsely punctate and pubescent, center with a shallow concave; clypeus rectangular, width 2× length, punctate and pubescent laterally and anteriorly, separated from frons by deep clypeal suture; labrum rectangular, narrower than clypeus, anterior margin with punctures and pubescence; antennae slender, exceeding humeri in length, antennomere 1 long and swollen, antennomere 2 short, 2/3 as long as antennomere 1, antennomere 3 as long as 4 and 1, antennomere 5 shorter than antennomere 4, antennomeres 6–10 as long as antennomere 2, antennomere 11 acute at apex, as long as antennomere 5; antennomeres 1–4 sparsely punctate and pubescent, antennomeres 5–11 densely punctate and pubescent.

Thorax: PW/PL = 1.3; anterior margin slightly flattened; posterior margin extended posteromedially ; length of posterior margin slightly longer than anterior margin; anterior groove distinct laterally, obsolete medially; posterior groove deep laterally, shallow medially; anterior portion of lateral margin subparallel, then gradually expanding from anterior portion to middle, strongly constricted behind middle; lateral tubercle rounded; behind the lateral tubercle, an oblique groove extending to basal portion; disc convex with dense and coarse punctures and pubescence, basal portion slightly depressed; basal portion of each side slightly prominent. Scutellum triangular, slightly emarginate at apex, densely punctate and pubescent.

Figures 100–102. Habitat of *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov. (Ningxia, Liupan Shan, Danangou). **100.** Habitat; **101, 102.** Host plants *Euonymus przewalskii* (Celastraceae) of *Z.* (*P.*) *liupanshanensis* sp. nov.

Elytra: EL/EW = 1.5–1.6; elytral humeri projecting antero-laterally, humeral groove shallow, lateral part of humeri densely punctate and pubescent; lateral margin slightly expanding from the base to the middle, widest behind the middle, apex slightly rounded; disc slightly flattened, coarsely punctate and pubescent; suture with one row of punctures and pubescence; epipleura narrow, two rows of punctures and pubescence at base and one row at apex.

Abdomen and legs: underside sparsely punctate and pubescent. Legs moderately long, femora robust, mid- and hind-tibiae slightly curved. Pygidium moderately long, apical portion exposed. Apical margin of last abdominal ventrite slightly prominent. Median lobe sclerotized, short and broad, curved in lateral view, dorso-central portion membranous, basal 1/3 tubular, sides thickened and parallel, apex triangular, strongly constricted and slightly sharp; median struts rod-shaped, widely separated from each other, ~2.2–2.4× as long as median lobe; basal portion of tegmen Y-shaped, tegminal ring subdiamond-shaped, paramere tongue-shaped, apical margin of paramere with setae; endophallus membranous, with weakly sclerotized area. Spiculum spoon-shaped, apical margin prominent.

Distribution. China (Ningxia).

Host plants. *Euonymus przewalskii*, *E. giraldii* (Celastraceae). We collected this species by beating the Celastraceae trees in the forest. One specimen was collected from *E. giraldii*, the other was from *E. przewalskii*. Several leaves were observed to have damage from bite marks (Fig. 106).

Etymology. The specific name *liupanshanensis* refers to the type locality, Liupan Shan.

Remarks. The pronotum shape of the new species is similar to that of *Zeugophora* (*Pedrillia*) *eumonymorum* Li & Liang, 2020 which is also found in Liupan Shan, but differs from the latter in having body mostly brown elytra with black spots, shorter antennae, the apex of the median lobe narrower (vs body dark blue or green, underside black, longer antennae, apex of median broader in *Z.* (*P.*) *eumonymorum*).

The external male genitalia of this species are similar to those of *Zeugophora* (*Pedrillia*) *annulata*, *Z.* (*P.*) *bicolor*, and *Z.* (*P.*) *tricolor* (Figs 25, 26, 30, 31, 69, 70), but differ from them in having a less curved median lobe in lateral view, and a shorter and less sclerotized apex of the median lobe, (more curved

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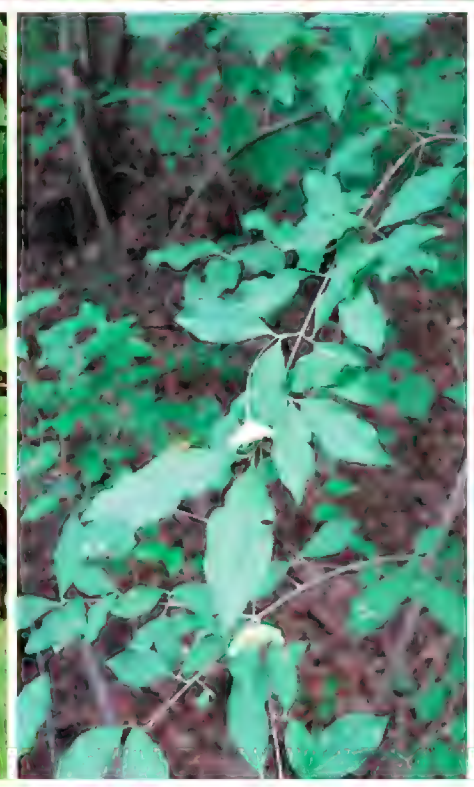

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Figures 103–106. Habitat and host plants of *Zeugophora* (*Pedrillia*) *liupanshanensis* sp. nov. (Ningxia, Liupan Shan, Longtan forest farm). **103.** Habitat; **104–106.** Host plant *Euonymus giraldii* (Celastraceae) of *Z.* (*P.*) *liupanshanensis* sp. nov.; **106.** Feeding traces on the abaxial leaf surface caused by adults.

median lobe in lateral view, apex of median lobe longer and more sclerotized in *Z.* (*P.*) *annulata*, *Z.* (*P.*) *bicolor*, and *Z.* (*P.*) *tricolor*).

This species is similar to *Zeugophora* (*Zeugophora*) *tetraspilota* Medvedev, 1998 (Fig. 110) in having posterior spots on elytra, but differs in having brown elytra with two black spots, a brown pronotum, black antennae, brown legs with black coloration, and a broader lateral tubercle on the pronotum (elytra yellowish brown with four black spots; pronotum, antennae, and legs yellowish brown, narrower lateral tubercle on the pronotum in *Z. tetraspilota*).

This species is also similar to *Zeugophora* (*Pedrillia*) *trisignata* An & Kwon, 2002 and *Z.* (*P.*) *bimaculata* Kratz, 1879 in having posterior spots on the elytra and in body shape, but differs from the latter in having a brown head, black antennae, brown legs with the posterior portion black, and antennomeres 3 and 4 longer (vs black head, antennomeres 1–4 yellowish brown, yellowish brown legs, antennomeres 3–4 shorter in *Z. trisignata* and *Z. bimaculata*, Figs 108, 109, respectively). The external male genitalia of this species differ from that of *Z.* (*P.*) *bimaculata* in having a narrower apex of the median lobe (apex of median lobe broader in *Z.* (*P.*) *bimaculata*).

Moreover, we found the elytra colorations of *Z.* (*P.*) *bimaculata* and *Z.* (*P.*) *trisignata* to be variable. The species *Z.* (*P.*) *bimaculata* has three kinds of coloration (Sergeev and Legalov 2022): one of them is the same as the type specimen of *Z.* (*P.*) *trisignata* (type locality Odaesan, Korea). The species *Z.* (*P.*) *trisignata* has two kinds of coloration (An and Kim 2020), of which one is the same as the type of *Z.* (*P.*) *bimaculata* (type locality Amur, Russia). Therefore, we compared descriptions and illustrations of the types of *Z.* (*P.*) *bimaculata* (Kraatz, 1879b; Fig. 108) and *Z.* (*P.*) *trisignata* (An and Kwon 2002; Fig. 109) as no specimens were available, and no significant difference was found in external morphology. We speculate *Z.* (*P.*) *trisignata* is probably conspecific with *Z.* (*P.*) *bimaculata*, but their genitalia should be compared to confirm this synonymy.

Figures 107–110. Types of *Zeugophora*. **107, 108.** Type of *Z.* (*Pedrillia*) *bimaculata* Kraatz, 1879; **109.** Holotype of *Z.* (*Pedrillia*) *trisignata* An & Kwon, 2002; **110.** Type of *Z.* (*Zeugophora*) *tetraspilota* Medvedev, 1998.

Discussion

In recent years, we collected many specimens of Chinese Zeugophorinae during expeditions, also examining their biology and host plants. We observed that species having host plants of the same genus or family have similar external male genitalia. For example, in the subgenus *Zeugophora*, the host plants all belong to the family Salicaceae (Chen 1974; Wu et al. 1982; Bukejs 2009; Sergeev and Legalov 2022); the species studied in this article have the similar characteristics of external male genitalia, such as the ratio of median strut / median lobe ≤ 1.5, the trifid apex of spiculum. The host plants of *Zeugophora hozumii* Chûjô, 1953, *Z. japonica* Chûjô, 1951, and *Z. cupka* Takemoto, 2019 from Japan and Russia are also species of the family Salicaceae (Takemoto 2019), and their external male genitalia have similar characteristics, the ratio of median strut / median lobe ≤ 1.5 and the trifid apex of spiculum.

In the subgenus *Pedrillia*, the host plants of *Zeugophora* (*Pedrillia*) *annulata*, *Z.* (*P.*) *bicolor*, *Z.* (*P.*) *tricolor*, *Z.* (*P.*) *nigricollis*, *Z.* (*P.*) *euonymorum*, and *Z.* (*P.*) *liupanshanensis* sp. nov. are Celastraceae, and those species have external male genitalia similar to each other and differing from species of *Zeugophora*, such as a membranous dorso-central portion of the median lobe with its tubular basal third, parallel sides, a tongue-shaped apical portion of the tegmen, and a prominent apex of the spiculum that is not trifid. According to Takemoto (2019), *Zeugophora unifasciata* (Jacoby, 1885), *Z. chujoi* Ohno, 1961, and *Z. flavonotata* (Chûjô, 1935) share similarities in their median lobe, tegmen, and spiculum with the Chinese species that feed on Celastraceae, and all of them are also recorded to have Celastraceae as their host plants.

The species *Zeugophora* (*Pedrillia*) *yunnanica*, *Z.* (*P.*) *trifasciata*, *Z.* (*P.*) *dimorpha*, and *Z.* (*P.*) *maculata*, *Z.* (*P.*) *flavithorax* have similar external male genitalia, such as the membranous median lobe dorso-central portion without a tubular basal third, thin parallel sides, and the apex of the spiculum usually trifid. Now that we know that the host plants of *Z.* (*P.*) *yunnanica*, *Z.* (*P.*) *maculata*, and *Z.* (*P.*) *flavithorax* are Symplocaceae, it explains the similarities. Other species such as *Zeugophora gede* Reid, 1998 from Indonesia and *Zeugophora varipes* Jacoby, 1885 from Japan also have similar external male genitalia to the three Chinese species, and their host plants are also Symplocaceae (Reid 1998, Takemoto 2019). Based on the similarity in genitalia, we speculate the host plant of *Z.* (*P.*) *dimorpha* and *Z.* (*P.*) *trifasciata* is probably also Symplocaceae.

Based on our observations, characteristics of external morphs, male genitalia, and information on host plants need to be examined together, to provide a more accurate classification of the Zeugophorinae.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Use of AI

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Author contributions

Kai-Qin Li collected specimens, dissected specimens, writing original draft, Yuan Xu dissected specimens, Hong-Bin Liang writing review and edition, all co-authors contributed to the draft of the manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text.

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